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The Impact of Technology Monopolization on the Technological Development and Foreign Economic Cooperation Policies of BRICS Countries

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Abstract: As the world economy has become more interconnected, technology's role as a driver of growth and a source of competitive advantage for businesses has grown in importance. The BRICS countries have been the engine of global economic growth for over a decade, but they now encounter varying degrees of opposition to their economic development. The developed world has implemented several strategies to preserve its position as the world's undisputed technological leader to maximize its profits and increase its market share. In order to accelerate economic growth, BRICS nations must work together to acquire cutting-edge technology that has been restricted from being exported to developing nations by developed nations. After providing a brief background on the technological monopolies of developed countries, this article analyzes the current state of technological development in the BRICS nations. Then it discusses the impact these monopolies have on technological progress before proposing countermeasures for foreign economic cooperation among the BRICS nations in light of these monopolies.

Keywords: technology monopolization, technological development, economic cooperation policy, BRICS

1. Introduction

1.1. Research Background

The globalization of science and technology has presented the majority of developing nations with enormous development challenges and opportunities. The ability of developing countries to seize this opportunity, strengthen international cooperation in science and technology, and positively participate in the globalisation process is crucial for them to reap the benefits of globalisation in science and technology, and represents a significant historical opportunity for them to catch up with developed nations. In the first decade of the 21st century, the average GDP growth rate of the BRICS countries exceeded 8%, which was significantly higher than the average growth rate of developed countries, which was 2.6%, and the average growth rate of the global economy, which was approximately 4.1%. However, the BRICS growth model relies heavily on the comparative advantage of traditional resource endowments rather than technological innovation and resource allocation efficiency [1]. Globally, the BRICS nations remain at the bottom of the value chain.

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To maintain their technological monopoly and ultimately achieve absolute military and economic superiority over developing countries and regions, developed countries impose strict restrictions on technology exports from developing countries and regions through legislation and adopt strict high-technology secrecy measures such as technical barriers to strengthen their control over technology exports and inhibit technology transfer, thereby depriving the former of technological advancement. What effect do technology monopolies have on the technological development of the BRICS? What sort of economic cooperation policies should they adopt within the international technological cooperation global network? Examining these questions will aid in determining how the BRICS nations can meet the opportunities and challenges of technological globalization. Moreover, the answers to these questions will contribute to promoting international technological cooperation in other developing nations, allowing them to adapt to the trend of internationalisation in allocating, managing, and achieving scientific and technological resources.

1.2. Literature Review

Galbraith advocates that technological monopolies are beneficial because they speed up innovation [2]. The majority of the money spent on research and development (R&D) comes from within the company itself. In the absence of competition, this kind of funding would be extremely difficult to come by without a technological monopoly that generates excess profits. Scale economies also apply to scientific investigations. Concentrated industries with technology monopolies benefit from economies of scale in R&D. Due to time and money constraints, small businesses cannot conduct extensive R&D. However, large corporations have the luxury of spreading their risky investments across many different endeavors. Technology monopolies have other benefits, such as protecting technological patents, increasing entry barriers, etc. Technology will advance rapidly if a high degree of monopoly [3]. Most academics take this stance because they believe monopoly profits are intrinsic to technological progress. In most cases, copying a new product is much cheaper than creating the original. The benefits of technological innovation for the innovating firm are diminished when the market is highly competitive, and the barriers to entry are low, a phenomenon known as "free-riding." The market structure will affect the incentive to innovate due to the multiplicative effects of technological progress [4]. So, it follows that a monopoly on the use of technology is essential for its development. Blakeley argues that the monopolization of technological resources is problematic [5]. Since the monopolist's current state is worth less as a result of the introduction of new technology or products, the monopolist will typically introduce new processes and products at a slower rate than is socially optimal, while competitive firms do not have this direct effect.

South Africa and China have the most potential for cooperation among the BRICS countries, according to a DSM model study of trade opportunities between South Africa and the other BRICS members [6]. It is challenging to examine economic cooperation among the BRICS countries due to their varied economic development models, as noted by Jacobs and Van Rossem [7]. The empirical study of international technological cooperation in OECD countries conducted by Guellec and De La Potterie found that the trend of international technological cooperation in OECD countries has increased significantly but that the degree of international technological cooperation varies greatly across countries [8]. International technical cooperation between Belgium and other countries is analyzed by Cincera et al. [9].

1.3. Research Gap

Most of the research on the effects of technological monopolies is broad in scope, focusing on the issue in general rather than on a select group of countries. It often fails to account for the economic and cultural differences between nations. While the aforementioned points of view have all contrib-

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uted to a more nuanced understanding of technological monopoly, they all tend to view it through the lens of monopoly, and their studies lack the depth necessary to understand the phenomenon fully. Not much has been said about the BRICS, but their involvement in pre-existing international and regional economic institutions has been studied. Second, from a national perspective, most of the current literature concerns about economic cooperation between China and India, China and Russia, and China and Brazil, with a particular emphasis on trade in services. Meanwhile, literature on win-win cooperation between the BRICS countries is scarce and not sufficiently detailed, covering only the problems and dilemmas of BRICS trade cooperation without exploring the realities, current situation, and internal mechanisms of BRICS cooperation. Studies on BRICS collaboration and technological monopoly, both theoretical and applied, are still in their formative stages. However, a wealth of relevant research perspectives requires additional analysis due to a lack of depth and breadth.

1.4. Research Framework

This paper is broken up into six sections. The primary goal of this paper is to organize the existing literature on BRICS countries' technological progress and economic cooperation. Part 2 defines "technology monopoly" and details the research methodology used throughout the paper. In the third section, this paper compares the paths and shortcomings of technological progress in BRICS countries with those in developed countries in order to identify the space for development in BRICS countries and analyze the current state of technological development in each BRICS member country. Finally, it clarifies the practical significance of this paper and its limitations by drawing conclusions and proposing solutions to the problems with technological development in the BRICS countries and by obtaining the methods of win-win cooperation among the BRICS countries from the perspective of economic cooperation.

2. Methods

2.1. Literature Review and Theoretical Analysis Method

The literature review and theoretical analysis method refer to the method of analyzing, judging, and deducing the content of historical literature, clarifying and defining the meaning of basic concepts, analyzing in detail the factors and structures that make up the literature, forming a scientific understanding of the facts through the study of the literature, and revealing its essential connotations and characteristics, based on the review of a large amount of literature related to technological monopolies. Technopoly is based on erecting a wide variety of technical barriers, using technology to erect barriers that are difficult to break the know-how in the central part of the technological chain, and then achieving a monopoly market and monopoly profits through technological control. The dual nature of technological monopoly and how it manifests and takes form are investigated. Finally, this paper seeks strategies to deal with a technological monopoly by analyzing the impact of technological monopoly on the technological advancement and foreign economic cooperation policies of the BRICS countries. The theoretical foundation of BRICS member countries' economic cooperation is analyzed, and the direction of the development of BRICS countries' economic cooperation is deduced by reviewing, collecting, and collating the relevant literature of BRICS countries.

2.2. Comparative Analysis Method

The comparative analysis method is used to compare and analyze two or more research objects using predetermined criteria to identify commonalities and differences and investigate underlying universal and particular laws. To better understand the technological differences between the

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BRICS and developed countries and think about economic cooperation in the context of each country's own circumstances, this paper will compare the technological development among the BRICS countries and their development paths with those of developed countries. First, a developing country can advance technologically through the economic opening by purchasing patented technologies from developed nations; second, a developing nation can attract FDI from developed nations; third, a developing nation can gain technological latecomer advantages by competing with developed nations and conducting their own research and development in an open economy; and fourth, a developing nation can advance technologically through independent research and development in an open economy. The study finds that BRICS countries do well in technological innovation and advocates for the exchange of technological know-how between them by focusing on the most fruitful avenues of bilateral and multilateral scientific collaboration.

3. Results

3.1. Development Status

Since the turn of the century, the BRICS countries have expanded their ability to pioneer new scientific discoveries and technological breakthroughs. China, South Africa, Brazil, Russia, and India increased their R&D spending from US$24.79 billion in 2000 to nearly US$505.6 billion in 2018, increasing their global share from less than 4% to 24%. There was a rise from 11.3% to 25.2% of the global share in the number of scientific and technical papers indexed by SCI; there was an increase from 55,000 to 1,529,700 in the number of invention patent applications; and there was an increase from 23,000 to 413,000 in the number of granted patents, accounting for 44.8% and 27.5% of the global share, respectively. This has allowed for rapid progress in scientific and technological innovations thanks to the collaboration between the five countries [10].

There has been an increase in high-tech product trade between BRICS countries recently, with China and India serving as the primary exporters. China supplied 39%, 36.2%, 35.8%, and 35.5% of South Africa, Brazil, and Russia's electromechanical product imports in 2019, respectively, in the world's largest trade of electromechanical products and transport equipment. In 2019, South Africa's 18% share of its imports of transportation equipment came from India and China, which ranked third and fifth, respectively. China was also Russia's fourth largest source of transportation equipment imports, supplying 10.5% of its imports. This is indicative of the symbiotic nature of the BRICS trade.

3.2. Existing Issues

Even so, the developed world will continue to be the most significant incubator of new ideas, especially in high technology. Due to the multiplicative effects of knowledge, fundamental innovations in developed countries serve as the cutting edge, and developing countries purposefully mimic these innovations. When developing countries' technological levels are low, and the gap between them and developed countries is wide, the cost of imitation is lower than the cost of innovation. Innovation should take a back seat to imitation in driving technological progress. Convergence between developing and developed world technologies raises the cost of imitation; when this rises above the cost of innovation, the latter should take precedence [11]. In order to achieve a seamless transition in the mode of technological progress, developing countries should prioritize strengthening their innovation capacity in the context of economic development. From the perspective of industries, it is more appropriate to promote the development of less developed industries through technological progress achieved through imitation than to emphasize independent innovation to seize the technological frontier in industries that have achieved faster development, especially high-tech industries.

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Regarding active patents, the BRICS countries still lag far behind the developed world, with only 22% of what the US has and 30% of what Japan has. Even Russia, which holds the record for the most active patents, held only 8.1% as many as the United States and 11% as many as Japan in 2012 [12]. Low investment in R&D means BRICS nations do not have many mutually beneficial IP royalty trade partners. The total value of IPR royalties imported by BRICS countries in 2018 was US$56.5 billion, roughly seven times the value of their exports, resulting in a trade deficit of US$48.4 billion. Therefore, the majority of BRICS' IPR royalty imports come from outside the BRICS group. In 2018, the United States, the European Union, Japan, and Korea supplied nearly 70% of China's IPR royalty imports, while the United States and the European Union supplied nearly 80% of Russia's IPR royalty imports. Unfortunately, no information regarding export flows exists for any country other than Russia. In 2018, Russia exported IPR royalties worth $880 million, with only $9 million going to BRICS countries (or about 1% of the total).

Only 161 inventions were patented in BRICS countries in 2018, accounting for 0.5% of all BRICS patented inventions, and only 29 were patented by other BRICS countries, accounting for 0.1% of all inventions in BRICS countries and 0.1% of all PCT applications in BRICS countries. The main cause of this situation is the lack of direct foreign investment between BRICS nations. Partnerships in international patent law are typically the result of multinational corporations expanding their R&D operations abroad. The home country is typically the patentee country, and the employee of the host country is typically the inventor when the R&D activities of multinational companies in the host country generate patents. It follows that a solid investment relationship between the two countries is necessary for long-term international patent cooperation. However, the BRICS countries' investment ties are weak at the moment. The Ministry of Commerce reports that FDI from BRICS countries into other BRICS countries was only 6% in 2017, and FDI attracted by BRICS countries was even lower. In China's case, the total amount of investment from BRICS countries in China from 2010-2018 was only USD 1.42 billion, or 0.12% of China's utilization of foreign investment.

3.3. Causes

The engine and fuel of economic growth are new technologies. Long-term technological monopolies impede new product development and innovation because they limit the number of potential market entrants. The primary goal of a technological monopoly is to gain an unfair advantage in the marketplace by limiting competition and increasing profits, which is achieved primarily through deploying sophisticated technical and human resources. The technology monopolies of developed countries have already gained much higher profits than those of developing country enterprises in the process of adapting to technological barriers through the introduction of technology and other means at a greater cost and are now in a virtuous circle, while the developing countries are one stumbling block away from joining them [13].

Developed nations have a large pool of skilled workers, developing nations have a disproportionately large number of unskilled workers, and capital-rich developed nations have a higher per capita GDP than labor-rich developing nations. To put it another way, not all technologies developed for developed countries are appropriate for developing countries because of the endogeneity of technological progress, which means that the structure of their factor endowments determines the rate of technological progress in developed countries. This means that the rate of technological progress in developed countries is biased towards capital and skilled labor, while the rate of technological progress in developing countries should be biased towards labor and unskilled labor. To put it another way, the BRICS countries' economic growth is stifled by their low levels of capital productivity [14]. Understanding that it is not better to be more advanced when introducing technology but

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that suitability should be considered and that only the linked development of the technological ladder and factor endowments can maximize the productivity of technology is crucial.

4. Discussion

Although both developed and developing nations require technological advancement to maintain their progress, the high income in developed nations represents a particularly high level of labor productivity, and their industrial technology and value-added are already ahead of the curve. Under these conditions, innovation in developed nations is strictly limited to domestic creations. A high degree of difficulty, expense, and danger is associated with inventing anything new.

Since the low income in developing countries now reflects the low labour productivity, this implies that their industrial technology is not cutting edge. Since developing nations are less technologically and industrially advanced than developed ones, they have the opportunity to innovate by adopting cutting-edge technology from the West [15]. This way, developing nations can catch up to, or even surpass, developed nations in terms of economic growth and technological advancement, as the cost and risk of technological innovation will be lower in the former. As a solution to the problem of technological monopoly, the BRICS nations should each make the most of the opportunities afforded by their unique strengths in science and technology innovation.

4.1. Technology Strengths of BRICS Countries

Russia has long been a leader in basic scientific research and is now a leader in numerous scientific fields, including physics, mathematics, earth sciences, chemistry, and the production of high-tech equipment. The Russian Academy of Sciences houses illustrious research institutes such as the Lebedev Institute of Physics and the Jofei Institute of Physics and Engineering, making it the premier institution in Russia for basic science research. Oil and gas corporations dominate the top technology rankings in Russia. Numerous nations rely on Russia's nuclear industry for innovative technologies and supplies. Rosatom consists of all Russian companies involved in the nuclear industry [11]. The Skolkovo Innovation Centre, also known as Russia's "Silicon Valley," comprises Skolkovo University, other educational institutions, and small start-ups. It is a leader among Russia's national research and innovation parks.

India excels internationally in information technology, aerospace, energy and environment, biomedical and technology, and marine science and technology. By implementing policies such as "Make in India," "Digital India," "Start-up India," and "Smart Cities," the government has reallocated funds for scientific research and development and is actively encouraging the creation of cutting-edge innovations throughout the nation. The IT industry in this country contributes significantly to the country's GDP. The information technology industry in India has become a significant contributor to the country's gross domestic product, accounting for nearly 10% of economic activity at present. The pharmaceutical industry in India is growing in international significance. India has mastered multi-rocket launch technology, and the country's satellite development and application technology are on par with international standards.

In the fields of biology, agriculture, and ecology, Brazil excels. Brazil has recently ramped up its efforts to build out its national research infrastructure, with the launch of the CMB-4 Earth rover and the construction of a third-generation synchrotron, naval hydrographic survey vessel, multipurpose reactor, and National Centre for Earth System Science all occurring in the past few years alone [16]. To foster new product development and transfer results, the Ministry of Science, Technology, Innovation, and Communication established the Technology System for Business Innovation and the Brazil Technology System Store, through which 400 research institutions share research equipment and software with companies.

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The government of South Africa invests heavily in fields like astronomy, paleoanthropology, biodiversity, Antarctic research, deep mining technology, microsatellite engineering, HIV vaccines, multimorbidity control, and fluorine technology, where it has a clear geographical advantage [17]. Some of South Africa's many scientific and technological innovation areas have attracted international attention: space research and technology, including archaeology, biotechnology, global change studies, mineral technology, and medicine. The Square Kilometre Array (SKA) radio telescope project is home in South Africa, a country that has emerged as a hub for international astronomical endeavors.

The Chinese have a leg up thanks to their developed industrial system and pool of human resources. In the United Nations' Industrial Directory, China is the only country with entries for every industry [18]. Shenzhen is the opposite of Silicon Valley, which has no comparable manufacturing advantage. In Shenzhen, it is possible to create a sample in a few days and produce it in mass quantities, both of which are difficult to achieve elsewhere.

4.2. Cooperation Policies of BRICS Countries

Furthermore, BRICS nations ought to deepen their technological and external economic cooperation [19]. The BRICS countries' domestic trade is in its infancy, and numerous and complex conflicts of interest exist among the member nations. In comparison to China, the populations of the other BRIC countries are small, but they possess extensive natural resources. Increased exploitation of these countries' natural resources, provided cooperation conditions are favorable, will yield sufficient funds and a strong market guarantee to boost the competitiveness of their export commodities. However, the above research suggests that BRICS countries' comparative advantages vary across industries and technological frontiers.

Thus, on the one hand, BRICS countries should continue to maintain and expand their comparative advantages in exports and promote the export of such commodities as China's high-tech products, which are highly competitive on the international market and have reached the world's top level by 2012. China needs to keep this advantage and expand its production capacity, all while working to increase international cooperation and create new opportunities for international collaboration in high-tech sectors. In contrast, unhealthy competition among BRICS countries in the international market is inevitable, as they are all at a stage of dynamic economic development, with similar development models and paths, and they are all at the lower end of the international industrial chain. In order to achieve this, the BRICS countries must cooperate while maintaining their individual identities, reduce unhealthy rivalries, and work toward shared prosperity.

5. Conclusion

The emergence of technological monopolies as one of modern capitalism's most distinctive features is not without risk for the BRICS countries, but it should serve as a wake-up call for them to adapt to the global economic trend. Having eliminated the monopoly of foreign corporations over technological advancements, the BRICS countries should now consider how to establish their own monopoly in this area.

Due to their inherent technological superiority, technology monopolies are currently commanding in driving technological progress. It's safe to say that this group develops and monopolizes most of the world's high technologies. When it comes to global technological competition, multinational corporations from developed countries have a monopolistic competitive advantage due to their superior access to capital, R&D capacity, technological reserves, technical talents, and market reputation. For the sake of technological advancement, this paper recommends adopting strategies to increase the level and efficiency of independent R&D, and for the sake of international economic co-

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operation, it recommends establishing strategic technological alliances for international cooperation. Fundamental countermeasures include fostering the ability to develop strategic technologies based on independent innovation, promoting intellectual property rights strategy, and the training and mobility of scientific and technological talents.

It is important for the BRICS countries to not only strengthen their technological development capabilities but also to learn how to apply technology monopoly competition strategies and to strengthen their own technology monopoly competitiveness in both competition and cooperation. Therefore, the development of technology monopoly and its pointing to technological progress in the relevant industries and multinational corporations of BRICS countries is of practical significance to the paper's context, as is the impact of technology monopoly on technological progress and foreign economic cooperation policies of BRICS countries.

This paper presents scant data on BRICS firms, focusing instead on theoretical analysis and discussion, and focuses on the negative aspects of technological monopoly for developing nations while omitting its inevitable positive aspects. Using firm-specific data, future research methods, such as empirical analysis, could be used to evaluate the scope and facets of the impact of technological monopolies in greater detail.

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